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(71)Applicant : FURUKAWA ELECTRIC CO LTD:THE
KAWASAKI STEEL CORP

(72)Inventor : KURAMOTO SHIGERU
KAKIO TETSUSHI
HAYASHI MINORU
TOTSUGI YOICHIRO
HASHIGUCHI KOICHI
YUKIMOTO MASAO

(54) AL-MG-SI ALLOY SHEET AND ITS PRODUCTION

(57)Abstract:

PROBLEM TO BE SOLVED: To produce an Al-Mg-Si alloy sheet which is the sheet obtd. by subjecting the directly cast and rolled sheet of an Al-Mg-Si alloy to cold rolling as well and having a small secular change and high age hardenability by the control of the conditions in casting and rolling, cold rolling, heat treatment or the like.

SOLUTION: This Al-Mg-Si alloy is the one obtd. by subjecting the directly cast and rolled sheet of an Al alloy having a compsn. contg., as essential elements, by mass, 0.2 to 3.0% Si and 0.2 to 3.0% Mg, one or ≥ two kinds among 0.01 to 0.5% Mn, 0.01 to 0.5% Cr, 0.01 to 0.5% Zr and 0.001 to 0.5% Ti, furthermore contg. one or ≥ two kinds among 0 to 2.5% Cu, 0 to 0.2% Sn and 0 to 2% Zn, in which the content of Fe is regulated to ≤1.0%, and the balance Al with inevitable impurities to cold

rolling as well. In this case, the maximum grain size in the metallic structure of this sheet is regulated to ≤100μm, and the maximum length of continuous Mg2Si compounds in the surface layer part is regulated to ≤50μm.

* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1]As an essential element, 0.2 to 3.0% (it is below the same mass%) of Si, Including 0.2 to 3.0% of Mg, 0.01 to 0.5% of Mn, and 0.01 to 0.5% of Cr, One sort of 0.01 to 0.5% of Zr and 0.001 to 0.5% of Ti or two sorts or more are included, Cu 0 - 2.5%, 0 to 0.2% of Sn, Zn 0 - 2.0% of one sort or two sorts or more are included, Regulate Fe to 1.0% or less, and the remainder a direct-casting-and-rolling board of an aluminum alloy which consists of aluminum and inevitable impurities, An aluminum-Mg-Si system alloy plate, wherein it is the cold-rolled board, and the maximum crystal grain diameter of a metal texture of the board is below 100 mum and length between couplings of a Mg_2Si compound in which a layer part continued is 50 micrometers or less.
[Claim 2]0.2 to 3.0% of Si and 0.2 to 3.0% of Mg are included as an essential element, 0.01 to 0.5% of Mn, 0.01 to 0.5% of Cr, and 0.01 to 0.5% of Zr, Including one sort of 0.001 to 0.5% of Ti, or two sorts or more, Cu 0 - 2.5%, 0 to 0.2% of Sn, Zn 0 - 2.0% of one sort or two sorts or more are included, Regulate Fe to 1.0% or less, and the remainder the pressing-down load P (ton) on conditions with which it is satisfied of the following ** type using a direct-casting-and-rolling device according an aluminum alloy molten metal which consists of aluminum and inevitable impurities to a congruence roll. Carry out direct casting and rolling to a board of 4 mm or less of board thickness, and also it cold-rolls by reduction of sectional area of the following 70% not less than 15% after that, Then, perform solution treatment in the range of melting temperature of 400 ** - material, and cooling after solution heat treatment is quenched below to 175 ** with a cooling rate more than 2 **/s, A manufacturing method of an aluminum-Mg-Si system alloy plate length between couplings of a Mg_2Si compound which reheated to 180 - 320 ** after that, and performed 0 - maintenance for 25 minutes, and in which a layer part continued the maximum crystal grain diameter of a metal texture of the board below in 100 mum being 50 micrometers or less.
** :P. $>=5.8 \times 10^{-6}$ and t-w-D$^{1/2}$, and v-exp$^{-0.5}$ [{1600/(T+273)} and (R/100)] It corrects, t: Appearance side

plate thickness (mm) and w:appearance side plate width (mm) D:roll diameter (mm) v:roll peripheral speed (mpm) and T : skin temperature (**) of an appearance side plate R: A rate of cold-rolling (%)
[Claim 3]On the aluminum alloy molten metal according to claim 2 and a rolled bar affair, and same conditions, direct casting and rolling is carried out to a board of 4 mm or less of board thickness, After that, cold-roll by reduction of sectional area of the following 70% above 15%, and solution treatment is continuously performed in the range of melting temperature of 400 ** - material, Cooling after solution heat treatment is quenched to the range of 40 - 175 ** with a cooling rate more than 2 **/s, A manufacturing method of an aluminum-Mg-Si system alloy plate length between couplings of a Mg_2Si compound in which it rolled round to a coiled form at said temperature, and a layer part continued the maximum crystal grain diameter of a metal texture of the board below in 100 mum being 50 micrometers or less.
[Claim 4]0.2 to 3.0% of Si and 0.2 to 3.0% of Mg are included as an essential element, 0.01 to 0.5% of Mn, 0.01 to 0.5% of Cr, and 0.01 to 0.5% of Zr, Including one sort of 0.001 to 0.5% of Ti, or two sorts or more, Cu 0 - 2.5%, 0 to 0.2% of Sn, Zn 0 - 2.0% of one sort or two sorts or more are included, Regulate Fe to 1.0% or less, and the remainder the pressing-down load P (ton) on conditions with which it is satisfied of the following ** type using a direct-casting-and-rolling device according an aluminum alloy molten metal which consists of aluminum and inevitable impurities to a congruence roll. Carry out direct casting and rolling to a board of 4 mm or less of board thickness, and also it cold-rolls by reduction of sectional area of not less than 70% after that, Then, perform solution treatment in the range of melting temperature of 400 ** - material, and cooling after solution heat treatment is quenched below to 175 ** with a cooling rate more than 2 **/s, A manufacturing method of an aluminum-Mg-Si system alloy plate length between couplings of a Mg_2Si compound which reheated to 180 - 320 ** after that, and performed 0 - maintenance for 25 minutes, and in which a layer part continued the maximum crystal grain diameter of a metal texture of the board below in 100 mum being 50 micrometers or less.
** :P. $>=2.9 \times 10^{-6}$ and t-w-D$^{1/2}$, and v-exp$^{-0.5}$ [{1600/(T+273)} and (R/100)] It corrects, t: Appearance side plate thickness (mm) and w:appearance side plate width (mm) D:roll diameter (mm) v:roll peripheral speed (mpm) and T : skin temperature (**) of an appearance side plate R: A rate of cold-rolling (%)
[Claim 5]On the aluminum alloy molten metal according to claim 4 and a rolled bar affair, and same conditions, direct casting and rolling is carried out to a board of 4 mm or less of board thickness, After that, cold-roll by the above reduction of sectional area 70%, and solution treatment is continuously performed in the range of melting temperature of 400 ** - material, Cooling after solution heat treatment is quenched to the range of 40 - 175 ** with a cooling rate more than 2 **/s, A manufacturing method of an aluminum-Mg-Si system alloy plate length between couplings of a Mg_2Si compound in which it rolled round to a coiled form at said temperature, and a layer part continued the maximum crystal grain diameter of a metal texture of the board below in 100 mum being 50

micrometers or less.

[Claim 6]After carrying out direct casting and rolling to a board of 4 mm or less of board thickness and rolling this round to a coiled form, A manufacturing method of the aluminum-Mg-Si system alloy plate according to claim 2 to 5 homogenizing maintenance for 2 to 24 hours (heating and the cooling rate 30 - 100 ** / time), and cold-rolling after that at temperature of 580 ** or less.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the aluminum-Mg-Si system alloy plate excellent in baking hardenability with little aging, and its manufacturing method.
The rolled plate of the suitable aluminum-Mg-Si system alloy for shaping still more specifically used for bending shaping of autoparts, home electronics, etc., press forming, etc., It is related with the aluminum-Mg-Si system alloy plate manufactured with direct casting and rolling which can be manufactured with a cheap manufacturing cost compared with conventional technology, and cold rolling, and its manufacturing method.
In this specification, although all the content of the alloying element of an aluminum alloy means mass%, it is only describing this as %.
[0002]
[Description of the Prior Art]The shell of a car, the chassis for household appliances, etc. fabricate the aluminum-Mg-Si system alloy plate which is excellent in corrosion resistance and ductility, and is aged with heating in predetermined shape, and after an appropriate time, age-hardening is baked, heated and carried out and they use it as a product paint and often. However, the aluminum-Mg-Si system alloy plate manufactured with the conventional manufacturing method, In order to check a deposit of the reinforcement phase according to the intermediate phase of Mg_2Si or it which is called beta' which a G.P. zone deposits in the room temperature after solution treatment, and contributes to improving strength by neglect (natural aging) at it at the time of the baking heating, In the material which has passed for a long time after solution treatment, the intensity after paint / baking heating was not fully obtained. Intensity rose with the deposit of a G.P. zone and ductility had also produced simultaneously the problem of falling remarkably.
[0003]As a method of solving this problem, it is JP,05-7460,B. The reserve aging treatment after solution treatment as shown, and JP,04-259358,A Restoration processing as shown, the processing

which combined them, etc. are devised. However, although it becomes possible by these processings to make the intensity rise at the time of paint and baking increase, without spoiling ductility, when a process increases, there is a problem to which a manufacturing cost becomes high. The conventional aluminum-Mg-Si system alloy rolled plate for shaping and its mold goods are manufactured as the following also including the manufacturing method of the aforementioned improvement. namely, -- these manufacture the ingot of predetermined alloy composition first -- this -- facing -- and -- homogenizing and continuing -- hot-rolling, cold rolling (it anneals if needed), solution treatment, the aforementioned reserve aging treatment or restoration processing, and shaping -- high temperature aging (paint / baking heating) is carried out, and it is manufactured. Thus, a manufacturing cost becomes high by the conventional manufacturing method having a dramatically long process, and needing large-sized equipment etc., and it is in the situation which cannot necessarily be said to be fit for industrial production.

[0004]

[Problem(s) to be Solved by the Invention]The technical problem of this invention controls the G.P zone which deposits at the time of natural aging by room temperature neglect, It is obtaining by combining the direct-casting-and-rolling method for the ability to manufacture the aluminum-Mg-Si system alloy plate for shaping with small aging a reinforcement phase's depositing promptly at the time of paint / baking heating, and high baking hardening being obtained, by low cost according to a process being very short etc., and the conventional cold rolling process. Other technical problems of this invention are finding out these desirable manufacturing conditions. As it is indicated in drawing 1 and drawing 2 as a direct-casting-and-rolling method here, the molten metal 4 is continuously supplied from the nozzle 3 between the congruence rolls 1 and 2, and immediately after the casting coagulation of a molten metal, it rolls with said congruence rolls 1 and 2, and is directly considered as a long rolled plate and its coil from a molten metal. Unlike the method of obtaining only a continuous casting board, generally this method is called a Hunter process, a direct rolling process, etc., but in this specification, it is considered as a direct-casting-and-rolling method. This manufacturing method performs between the process used as the ingot or ** board currently conventionally performed by the separated process, a homogenization process, and heat, a cold rolling process, etc. at one process, and has an advantage which can skip many processes.

[0005]

[Means for Solving the Problem]An invention of claim 1 for solving said technical problem, As an essential element, 0.2 to 3.0% (it is below the same mass%) of Si, Including 0.2 to 3.0% of Mg, 0.01 to 0.5% of Mn, and 0.01 to 0.5% of Cr, One sort of 0.01 to 0.5% of Zr and 0.001 to 0.5% of Ti or two sorts or more are included, Cu 0 - 2.5%, 0 to 0.2% of Sn, Zn 0 - 2.0% of one sort or two sorts or more are included, Regulate Fe to 1.0% or less, and the remainder a direct-casting-and-rolling board of an aluminum alloy which consists of aluminum and inevitable impurities, It is an aluminum-Mg-Si system alloy plate, wherein it is the cold-rolled board, and the maximum crystal grain diameter of a metal

texture of the board is below 100 mum and length between couplings of a Mg_2Si compound in which a layer part continued is 50 micrometers or less, [0006]An invention of claim 2 as an essential element 0.2 to 3.0% of Si, Including 0.2 to 3.0% of Mg, 0.01 to 0.5% of Mn, and 0.01 to 0.5% of Cr, One sort of 0.01 to 0.5% of Zr and 0.001 to 0.5% of Ti or two sorts or more are included, Cu 0 - 2.5%, 0 to 0.2% of Sn, Zn 0 - 2.0% of one sort or two sorts or more are included, Regulate Fe to 1.0% or less, and the remainder the pressing-down load P (ton) on conditions with which it is satisfied of the following ** type using a direct-casting-and-rolling device according an aluminum alloy molten metal which consists of aluminum and inevitable impurities to a congruence roll. Carry out direct casting and rolling to a board of 4 mm or less of board thickness, and also it cold-rolls by reduction of sectional area of the following 70% above 15% after that, Then, perform solution treatment in the range of melting temperature of 400 ** - material, and cooling after solution heat treatment is quenched below to 175 ** with a cooling rate more than 2 **/s, It is a manufacturing method of an aluminum-Mg-Si system alloy plate length between couplings of a Mg_2Si compound which reheated to 180 - 320 ** after that, and performed 0 - maintenance for 25 minutes, and in which a layer part continued the maximum crystal grain diameter of a metal texture of the board below in 100 mum being 50 micrometers or less, ** :$P. >= 5.8 \times 10^{-6}{}_{\text{and t-w-D}}{}^{1/2}{}_{\text{, and v-exp}}{}^{-0.5}$ [{1600/(T+273)} and (R/100)] It corrects, t: Appearance side plate thickness (mm) and w:appearance side plate width (mm) D:roll diameter (mm) v:roll peripheral speed (mpm) and T : skin temperature (**) of an appearance side plate R: Rate of cold-rolling (%) [0007]Inventions of claim 3 are said aluminum alloy molten metal according to claim 2 and a rolled bar affair, and the same conditions, Carry out direct casting and rolling to a board of 4 mm or less of board thickness, and also it cold-rolls by reduction of sectional area of the following 70% above 15% after that, Then, perform solution treatment in the range of melting temperature of 400 ** - material, and cooling after solution heat treatment is quenched to the range of 40 - 175 ** with a cooling rate more than 2 **/s, It is a manufacturing method of an aluminum-Mg-Si system alloy plate length between couplings of a Mg_2Si compound in which it rolled round to a coiled form at said temperature, and a layer part continued the maximum crystal grain diameter of a metal texture of the board below in 100 mum being 50 micrometers or less. [0008]An invention of claim 4 as an essential element 0.2 to 3.0% of Si, Including 0.2 to 3.0% of Mg, 0.01 to 0.5% of Mn, and 0.01 to 0.5% of Cr, One sort of 0.01 to 0.5% of Zr and 0.001 to 0.5% of Ti or two sorts or more are included, Cu 0 - 2.5%, 0 to 0.2% of Sn, Zn 0 - 2.0% of one sort or two sorts or more are included, Regulate Fe to 1.0% or less, and the remainder the pressing-down load P (ton) on conditions with which it is satisfied of the following ** type using a direct-casting-and-rolling device according an aluminum alloy molten metal which consists of aluminum and inevitable impurities to a congruence roll. Carry out direct casting and rolling to a board of 4 mm or less of board thickness, and also it cold-rolls by the above reduction of sectional area 70% after that, Then, perform solution treatment in the range of melting temperature of 400 ** - material, and cooling after solution heat

treatment is quenched below to 175 ** with a cooling rate more than 2 **/s, It is a manufacturing method of an aluminum-Mg-Si system alloy plate length between couplings of a Mg_2Si compound which reheated to 180 - 320 ** after that, and performed 0 - maintenance for 25 minutes, and in which a layer part continued the maximum crystal grain diameter of a metal texture of the board below in 100 mum being 50 micrometers or less, ** :P. >=2.9 x10 $^{-6}$ and t-w-D $^{1/2}$, and v-exp $^{-0.5}$ [{1600/(T+273)} and (R/100)] It corrects, t: Appearance side plate thickness (mm) and w:appearance side plate width (mm) D:roll diameter (mm) v:roll peripheral speed (mpm) and T : skin temperature (**) of an appearance side plate R: Rate of cold-rolling (%) [0009]Inventions of claim 5 are said aluminum alloy molten metal according to claim 4 and a rolled bar affair, and the same conditions, Carry out direct casting and rolling to a board of 4 mm or less of board thickness, and also it cold-rolls by the above reduction of sectional area 70% after that, Then, perform solution treatment in the range of melting temperature of 400 ** - material, and cooling after solution heat treatment is quenched to the range of 40 - 175 ** with a cooling rate more than 2 **/s, It is a manufacturing method of an aluminum-Mg-Si system alloy plate length between couplings of a Mg_2Si compound in which it rolled round to a coiled form at said temperature, and a layer part continued the maximum crystal grain diameter of a metal texture of the board below in 100 mum being 50 micrometers or less.

[0010]After carrying out direct casting and rolling of the invention of claim 6 to a board of 4 mm or less of board thickness and rolling this round to a coiled form, 580 It is a manufacturing method of said aluminum-Mg-Si system alloy plate according to claim 2 to 5 homogenizing maintenance for 2 to 24 hours (heating and the cooling rate 30 - 100 ** / time), and cold-rolling after that at temperature below **.

[0011]

[Embodiment of the Invention]The invention of claim 1 relates to a direct-casting-and-rolling method and the board obtained by cold rolling among the inventions of each of said claim, and the invention of claims 2-6 relates to the manufacturing method of said board. Hereafter, said each invention is explained in detail.

[0012](1) Explain the reason which limited the alloy composition of the board concerning this invention for the invention of claim 1 like the above first. At the time of paint / baking heating, with Mg, Si deposits as a reinforcement phase according to the intermediate phase of Mg_2Si or it which is called beta', and raises intensity. The addition was limited with 0.2 to 3.0% in order for the ductility after solution treatment to fall, if the effect is small and 3.0% is exceeded [less than 0.2%]. Mg is dissolving in a matrix after solution treatment, and is contributed to ductile improvement. As mentioned above, at the time of paint / baking heating, with Si, it deposits as a reinforcement phase and intensity is raised. The addition was limited with 0.2 to 3.0% in order for the ductility after solution treatment to fall, if the effect is small and 3.0% is exceeded [less than 0.2%]. As mentioned above, Si and Mg deposit as a reinforcement phase at the time of paint / baking heating, and raise intensity.

When the abundance ratios of both this element differ, those baking hardenability also differs, when the weight ratio of Si and Mg is Si>0.6Mg% , it is set to superfluous Si to the amount of Mg_2Si, and the more outstanding baking hardenability is acquired. In order to control the prescription action at the time of paint / baking heating, even if it adds a little Ag, Cd(s), etc., the effect of this invention is not spoiled.

[0013]Mn, Cr, Zr, and Ti are added in order to raise the minuteness making or matrix intensity of a crystal grain, respectively. The addition is one sort of 0.01 to 0.5% of Mn, 0.01 to 0.5% of Cr, 0.01 to 0.5% of Zr, and 0.001 to 0.5% of Ti, or two sorts or more if needed. At less than a minimum, there are few effects, and if a maximum is exceeded, the ductility after solution treatment will fall, respectively. Cu, Sn, and Zn deposit at the time of paint / baking heating, and raise intensity. Addition of Sn is effective in improving surface quality. The addition is one sort of 0 to 2.5% of Cu, 0 to 0.2% of Sn, and 0 to 2.0% of Zn, or two sorts or more if needed. Here, in 0%, also when each element does not add, it means a certain thing. By the case where it adds, each element was limited with 2.5% or less, 0.2% or less, and 2.0% or less, respectively because corrosion resistance would fall and evils, like quenching susceptibility becomes high would be produced, if these are exceeded. Fe is usually contained as an impurity of aluminum. However, Fe tends to make Si and a compound, and if contained exceeding 1.0%, it will check the improving strength at the time of heating in the case of paint and baking. If B usually added as minuteness making material of cast structure is 0.1% or less of addition, it will not spoil the effect in particular of this invention.

[0014]Next, it is because it is not preferred as a molding material that surface deterioration arises after shaping with which ductility sufficient as a charge of shaping material is not obtained etc. as for below 100 mum having carried out the maximum crystal grain diameter in the metal texture of the rolled plate of this invention when exceeding 100 mum. That the length between couplings of the continuous Mg_2Si compound set to 50 micrometers or less in the metal texture of the layer part of the rolled plate concerning this invention, It is because the amounts of dissolution run short and the improving strength at the time of paint / baking heating becomes less enough, when the big and rough main solute system compound containing Mg that the aforementioned length between couplings exceeds 50 micrometers, and Si has already deposited before paint / baking. The board thickness of the rolled plate concerning this invention is about 0.7-3 mm. Although the contents of the aluminum-Mg-Si system alloy plate concerning this invention are as above and it is **, Also in the example described later, in heating at the time of the paint and baking after shaping, before improvement in intensity (YS) heating, it is compared, it becomes [this rolled plate excels / elongation / before paint / baking heating / in a moldability at not less than 27%, and] high 100 or more MPa, and fits the molding material of the above various applications so that clearly.

[0015](2) After the invention of claims 2 and 3 relating to the manufacturing method of the rolled plate concerning the invention of said claim 1 about the invention of claims 2 and 3 and carrying out direct casting and rolling, they are cold rolling and a thing heat-treated and manufactured about this. If this

direct-casting-and-rolling method of this invention is explained by a diagram concretely, it will let the nozzle 3 pass for said aluminum alloy molten metal 4 according to claim 1 using a direct-casting-and-rolling device with a congruence roll as shown in drawing 1 and drawing 2, Supply continuously between the congruence rolls 1 and 2, and it is made to cast and solidify between the closest-approach points A of the congruence rolls 1 and 2 from the tip B of the nozzle 3, and rolls near the A point. In drawing 2, C point is the last coagulating point of a molten metal. After this invention performs cold rolling and solution treatment to the direct-casting-and-rolling board manufactured in this way further, it is quenched to it, and it performs a reheating process (claim 2) or high temperature coil rolling up (claim 3) to it succeedingly.

[0016]These manufacturing methods are characterized by realizing processing required in order to control a metal texture called the coagulation in DC casting of a conventional method, and plastic working in hot-rolling by direct casting and rolling with one congruence roll, and become very important [defining appropriately the direct-casting-and-rolling conditions in this congruence roll]. In order to find out such conditions, examination from a fundamental viewpoint is energetically performed about the relation between the conditions of congruence roll direct casting and rolling, a metal texture, and a mechanical property, It is the pressing-down load P (ton) applied to a congruence roll as a result :P The following ** type and ** >=5.8 x10 $^{-6}$ and t-w-D $^{1/2}$, and v-exp $^{-0.5}$ [{1600/(T+273)} and (R/100)] Correct, t: Appearance side plate thickness (mm) and w:appearance side plate width (mm) D:roll diameter (mm) v:roll peripheral speed (mpm) and T : skin temperature (**) of an appearance side plate R : on the conditions with which it is satisfied of the rate of cold-rolling (%). After carrying out direct casting and rolling to the board of 4 mm or less of board thickness, 70% above 15% Cold rolling of the following, Then, it found out that it was possible to manufacture the aluminum-Mg-Si system alloy plate which has performance equivalent to a conventional method by performing solution treatment in the range of the melting temperature of 400 ** - material, and quenching cooling after solution heat treatment below to 175 ** with the cooling rate more than 2 **/s. It is the pressing-down load P (ton) here :P ** >=5.8 x10 $^{-6}$ and t-w-D $^{1/2}$, and v-exp Having considered it as {1600/(T+273)} and (R/100) $^{-0.5}$, In pressing-down load smaller than this, the plastic deformation irreversible deformation from the end of coagulation runs short, and division of a crystallization phase is not fully performed, but it is for elongation to fall compared with the case where it manufactures with a conventional method, and as big pressing down as the case where the rate of the last cold-rolling is small is needed. The rolling reduction at the time of cold-rolling of a post process of this conditional expression is a case of the following 70% above 15%. Although restriction in particular is not provided about the cooling rate after direct casting and rolling, in order to fully demonstrate the effect of subsequent solution treatment, cooling at as quick a speed as possible is desirable.

[0017]Being because grinding of an organization produced at the time of coagulation fully not being performed in the case of not more than this but having considered the rate of cold-rolling as the

above 15% causing a ductile fall, and having carried out the maximum the following 70%, It is because the things with an above-mentioned conditional expression of the pressing-down load at the time of direct casting and rolling differ in the case of the rate of cold-rolling exceeding 70%. Having made solution treatment temperature more than 400 ** in order to make Mg and Si dissolve, and quenching to the temperature below 175 ** with the cooling rate more than 2 **/s, Although it is the 1st purpose to make supersaturation dissolve without producing a deposit of alloying elements, such as Si, Mg, etc. which are dissolving before cooling, as much as possible, to deposit a reinforcement phase detailed at the time of next paint / baking heating, and to raise intensity, 2 It is because a big and rough compound deposits during cooling, so the fall of elongation will also be caused in cooling to the cooling rate of less than **/s, or the temperature more than 175 **.

[0018]In a manufacturing method given in claims 2 and 3 of this invention, After above-mentioned solution treatment, it quenches below to 175 ** with the cooling rate more than 2 **/s, reheating to 180 - 320 ** after that -- the maintenance for 0 - 25 minutes -- carrying out (claim 2: restoration processing). Or after above-mentioned solution treatment, it quenches to the range of 40 - 175 ** with the cooling rate more than 2 **/s, and rolling up (claim 3: high temperature coil rolling up) is needed for a coiled form at said temperature. Although it is possible to manufacture the plate of performance almost equivalent to the plate obtained at the conventional process also by an above-mentioned process, this, It is because the problem that a G.P. zone deposits by natural aging like a conventional method, the intensity after paint / baking heating is not fully obtained, or intensity rises and a moldability falls remarkably arises. As well as a conventional method when based on direct casting and rolling with a congruence roll, it is necessary to control the G.P. zone generation by natural aging by above-mentioned restoration processing or high temperature coil rolling up.

[0019]Although the manufacturing method of claim 2 is quenched to the temperature after solution treatment and below 175 ** like the above and a reheating process (restoration processing) is performed succeedingly, this processing is reheated to 180 - 320 **, performs 0 - maintenance for 25 minutes, and cools them radiationally to a room temperature after that. When the maintenance for zero reaches the temperature of not holding, i.e., 180 - 320 **, it is a meaning which cooling without holding also includes here. As for this reheating process, it is preferred to usually carry out with a continuous annealing furnace (CAL). Although the manufacturing method of claim 3 is quenched to the temperature of 40 - 175 ** after solution treatment, rolls round in a coil in this temperature requirement (high temperature coil rolling up) and processes neglect etc. to a room temperature after that like the above, The processing after this high temperature coil rolling up may neglect and cool a winding coil radiationally to a room temperature as it is, and at rolling-up temperature (40-175 **), it may be held in a furnace for less than 36 hours, and it may cool it radiationally after that. After high temperature coil rolling up, a room temperature may be neglected and followed for a while, and it may hold in the furnace of 40 - 175 ** for less than 36 hours, and may cool radiationally after that. The method by which the processing after these elevated-temperature rolling up is known from the former

about the aluminum-Mg-Si system alloy is applied if needed. The heat treatment condition of this restoration processing and high temperature coil rolling-up processing has a range because predetermined performance is not obtained even if less than a minimum exceeds a maximum again. The effect is not spoiled, even if it performs restoration processing after not restricting and neglecting it several months or more about solution treatment, then especially the room temperature leaving times from quenching to restoration processing implementation.

[0020](3) The invention of claims 4 and 5 relates to another manufacturing method of the rolled plate concerning the invention of said claim 1 about the invention of claims 4 and 5. Namely, it is a case where the cold rolling rate after direct casting and rolling exceeds 70% in the manufacturing method of a statement to said claims 2 and 3, In this case, it is the pressing-down load P concerning a congruence roll (ton) :P ** type and ** >=2.9 x10 $^{-6}$ $_{\text{and t-w-D}}$ $^{1/2}$, $_{\text{and v-exp}}$ $^{-0.5}$ [{1600/(T+273)} $_{\text{and}}$ (R/100)] Correct, t: Appearance side plate thickness (mm) and w:appearance side plate width (mm) D:roll diameter (mm) v:roll peripheral speed (mpm) and T : skin temperature (**) of an appearance side plate R: It is considered as the rate of cold-rolling (%), and the conditions about pressing-down load are changed to claims 2 and 3 compared with the case of a statement. This is because the case of claims 2 and 3 does not have to enlarge pressing-down load at the time of direct casting and rolling in order to perform division of a crystallization phase during cold-rolling if a cold rolling rate exceeds 70%. It is the same as that of the case of claims 2 and 3 that big pressing down is needed as the case where the rate of the last cold-rolling is small. The conditions of the solution treatment after cold rolling, quenching, restoration processing (claim 4), or high temperature coil rolling up (claim 5), meaning, an effect, etc. are the same with having explained by aforementioned claims 2 and 3.

[0021](4) It is a manufacturing method which direct casting and rolling of the invention of claim 6 is carried out, it is rolled round in a coil in the manufacturing method according to claim 2 to 5, and homogenizes this, and cold-rolls continuously about the invention of claim 6. Such homogenization can be performed for the purpose of a deposit of the disperse phase particles containing dissolution and the transition element of the solidifying segregation of a direct-casting-and-rolling board, and, thereby, can aim at a ductile improvement and improvement in intensity. This homogenization condition was considered as maintenance (heating and cooling-rate 30-100 **/time) at the temperature below 580 ** for 2 to 24 hours in order to obtain the characteristic of the above-mentioned purpose.

[0022]As explained above, it becomes possible to manufacture the aluminum-Mg-Si system alloy plate which is excellent in the small baking hardenability of aging by low cost by this invention. Since processes, such as ingot making to the preceding paragraph story of that for which the restoration processing for controlling natural aging like a conventional method or elevated-temperature rolling up is needed, facing, homogenization, hot-rolling, and cold rolling, are simplified substantially, a total manufacturing cost is reduced substantially.

[0023]

[Example]Next, an example (example of this invention) is described for this invention still in detail with a comparative example. The aluminum-Mg-Si system molten metal of the presentation shown in Table 1 was made into the board with a direct-casting-and-rolling device with the congruence roll of the horizontal type shown in drawing 1 and drawing 2, this was cold-rolled further, and the 0.7-3-mm-thick plate was manufactured. The details of these manufacturing conditions are shown in Table 2.

[0024]

[Table 1]

	合金 No.	合金の化学組成 (mass%)										
		Si	Mg	Fe	Cu	Sn	Zn	Mn	Cr	Zr	Ti	Al
本発明例	1	1.4	0.4	0.2	-	-	-	-	-	-	0.02	残部
	2	0.8	0.4	0.2	0.4	-	-	-	-	-	0.02	残部
	3	0.8	0.4	0.2	0.3	-	-	0.2	-	-	0.02	残部
	4	1.0	0.4	0.1	-	-	-	-	0.05	-	0.02	残部
	5	0.8	0.4	0.1	0.8	-	-	-	-	0.06	0.02	残部
比較例	6	0.05	0.4	0.2	0.4	-	-	-	-	-	0.02	残部
	7	4.2	0.4	0.2	0.4	-	-	-	-	-	0.02	残部
	8	1.4	0.15	0.2	-	-	-	-	-	-	0.02	残部

[0025]

[Table 2]

	製法記号	合金No.	連続鋳造圧延条件 荷重 P(ton)	出側板の表面温度 T(℃)	出側板厚 t(mm)	出側板幅 w(mm)	ロール周速 v(mpm)	ロール径 D(mm)	式値 *	均質化熱処理条件 (℃×時間)	冷延率 R(%)	溶体化処理 熱処理条件 (℃×秒)	溶体化後の冷却速度 (℃/s)	再加熱処理条件 (℃×秒)	高温コイル処理 コイル巻き取り温度	コイル巻き取り後の処理	(備考) 対応請求項
本発明例	A	1	40	419	2.12	150	15.0	480	8.65	なし	50	540 ×0	5	240 ×0	なし		請求項2
	B	2	40	430	2.02	100	4.8	480	2.19	なし	30	540 ×0	5	240 ×0	なし		請求項2
	C	3	70	307	1.62	200	6.8	580	6.87	なし	50	540 ×0	5	240 ×0	なし		請求項2
	D	4	15	302	3.95	150	4.8	580	3.59	なし	80	540 ×0	5	240 ×0	なし		請求項4
	E	5	60	314	3.88	150	13.0	580	9.02	なし	80	540 ×0	5	なし	100 ℃	室温に放置	請求項5
	F	1	60	410	2.05	150	13.0	580	8.22	なし	50	540 ×0	5	なし	100 ℃	100 ℃で24H 保持	請求項3
	G	1	60	410	2.08	150	13.0	580	8.34	560×24	50	540 ×0	5	なし	70 ℃	放置後100 ℃で24H 保持	請求項6
比較例	H	1	15	272	2.07	150	15.0	480	20.35	なし	30	540 ×0	5	240 ×0	なし		
	I	1	60	410	1.05	150	13.0	580	9.41	なし	10	540 ×0	5	なし	100 ℃	室温に放置	
	J	3	40	294	2.02	200	13.0	480	15.86	なし	50	540 ×0	1	240 ×0	なし		
	K	5	40	402	1.95	150	10.11	580	6.25	なし	50	540 ×0	5	なし	なし		
	L	6	70	305	2.06	200	6.8	580	8.82	なし	50	540 ×0	5	240 ×0	なし		
	M	7	40	302	1.33	150	4.8	580	5.58	なし	15	540 ×0	5	なし	100 ℃	室温に放置	
	N	8	60	416	1.97	150	13.0	580	7.74	なし	50	540 ×0	5	なし	100 ℃	室温に放置	

注：* 式値（冷延率70%未満）$=5.8\times10^{-4}\cdot t\cdot w\cdot D^{1/2}\cdot v\cdot \exp\,[1600/(T+273)]\cdot(R/100)^{-0.5}$
* 式値（冷延率70%以上）$=2.9\times10^{-4}\cdot t\cdot w\cdot D^{1/2}\cdot v\cdot \exp\,[1600/(T+273)]\cdot(R/100)^{-0.5}$

[0026]About the plate manufactured in this way, the maximum crystal grain diameter in the metal texture of a board was measured with the optical microscope. Using the scanning electron

microscope, the reflection electron image was observed and the length between couplings of the Mg_2Si compound in which the layer part continued was measured. After [1, 5, 20, and 60] manufacture During the day, the tensile test was carried out, after neglecting it to a room temperature. Furthermore, paint / baking heating was simulated. The tensile test was done also after performing heating for 60 minutes at 175 **. The tensile test measured tensile strength, proof stress, and elongation with the JIS No. 5 test piece for tensile test. These results are shown in Table 3.

[0027]

[Table 3]

	製法記号	金属組織		機械的特性											
		最大結晶粒径 (μm)	最大長さ50μmを越えるMg2Siの有無	放置日数	1日後			5日後			20日後			60日後		
				加熱の前、後	TS (MPa)	YS (MPa)	El (%)	TS (MPa)	YS (MPa)	El (%)	TS (MPa)	YS (MPa)	El (%)	TS (MPa)	YS (MPa)	El (%)
本発明例	A	52	無	加熱前	240	114	29.6	238	121	29.9	238	127	29.5	238	127	29.6
				加熱後	295	241	24.6	290	244	24.8	298	249	26.3	292	251	25.7
				増分	55	127		52	123		60	122		54	124	
	B	84	無	加熱前	229	123	30.3	238	121	30.1	238	127	32.1	238	127	29.7
				加熱後	285	244	27.4	290	239	23.1	298	244	26.8	292	245	24.2
				増分	57	121		52	118		60	117		54	118	
	C	55	無	加熱前	236	107	28.9	238	111	32.4	238	117	32.8	238	117	30.7
				加熱後	288	233	24.4	290	235	24.5	298	240	24.1	292	241	26.5
				増分	52	126		52	124		60	123		54	124	
	D	48	無	加熱前	232	115	29.4	238	121	32.0	238	127	30.5	238	127	32.1
				加熱後	274	239	23.0	290	242	25.9	298	247	26.2	292	248	25.9
				増分	42	124		52	121		60	120		54	121	
	E	45	無	加熱前	229	123	30.3	238	121	31.5	238	127	30.3	238	127	29.7
				加熱後	285	244	27.4	290	239	23.1	298	244	26.8	292	245	24.2
				増分	57	121		52	118		60	117		54	118	
	F	58	無	加熱前	242	120	30.9	243	123	27.2	238	123	28.6	238	122	29.2
				加熱後	303	244	26.6	299	245	22.9	298	236	23.5	292	232	25.7
				増分	61	124		56	122		60	113		54	110	
	G	42	無	加熱前	242	119	34.2	243	121	34.5	238	121	33.2	238	123	33.0
				加熱後	303	244	26.6	299	242	22.9	298	236	23.5	292	234	25.7
				増分	61	125		56	121		60	115		54	111	
比較例	H	137	有	加熱前	200	114	15.9	204	121	15.7	203	127	16.0	201	127	15.4
				加熱後	245	160	11.0	244	165	10.9	243	164	10.9	238	159	11.3
				増分	45	46		40	44		40	37		37	32	
	I	227	無	加熱前	227	112	23.3	233	113	24.1	245	111	23.7	249	111	23.5
				加熱後	277	234	22.1	279	233	23.7	288	231	22.8	293	235	22.1
				増分	50	122		46	120		43	120		44	124	
	J	56	有	加熱前	227	130	27.5	233	129	27.3	245	137	26.9	249	144	27.0
				加熱後	277	195	26.4	279	194	23.7	288	193	22.8	293	189	25.6
				増分	50	65		46	65		43	56		44	45	
	K	49	無	加熱前	245	143	31.7	245	147	31.0	248	158	29.8	257	159	30.0
				加熱後	297	212	24.4	302	200	22.6	306	200	22.0	312	208	24.7
				増分	52	69		57	53		58	42		55	49	
	L	58	無	加熱前	176	86	26.9	180	88	27.3	175	87	27.8	174	87	27.2
				加熱後	173	87	26.5	172	87	25.9	177	89	26.1	176	86	26.4
				増分	-3	1		-8	1		1	1		2	-1	
	M	105	無	加熱前	248	159	14.9	252	159	13.8	255	155	13.4	259	160	13.8
				加熱後	317	276	12.1	316	267	10.9	305	264	11.3	311	266	11.4
				増分	69	117		64	109		50	109		52	106	
	N	58	無	加熱前	233	136	32.8	231	135	33.0	234	134	31.8	234	132	32.2
				加熱後	255	152	30.6	248	154	30.6	254	158	31.2	256	158	30.5
				増分	22	16		17	19		20	24		22	26	

注) 合格基準値：加熱によるYS増加分≧100MPa、加熱前の伸び≧27%

[0028]In a rolled plate of this invention, and a manufacturing method (A-G) for the same, it turns out

that the proof stress rise by heating in the case of paint and baking is excellent also in the ductility (elongation) before heating (27% above), and further excellent in the stability by room temperature neglect of these characteristics greatly (100 or more MPa) so that more clearly than Table 3. On the other hand, it turns out that the comparative example (H-N) which separates from the presentation specified by this invention, or separates from the manufacturing conditions of this invention is inferior also in respect of the ductility (elongation) before heating small [the proof stress rise before and behind heating].

[0029]

[Effect of the Invention]Thus, according to an aluminum-Mg-Si system alloy plate concerning this invention, and a manufacturing method for the same. The deposit of the G.P. zone at the time of natural aging is controlled, a reinforcement phase deposits promptly with heating in the case of paint and baking, and aging can obtain the aluminum-Mg-Si system alloy plate which has small high age-hardening nature by low cost, and does a prominent effect so on industry.

[Translation done.]